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Review

A Review of Eco-Product Value Realization and Eco-Industry with Enlightenment toward the Forest Ecosystem Services in Karst Ecological Restoration

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Abstract: Eco-product value realization and eco-industry are in a rapid development stage, but the eco-product value realization mechanism is still unclear. Strengthening research on eco-industry and eco-product value realization not only helps to coordinate the relationship between regional ecologies and the economy but also contributes to regional sustainable development. This study conducted a systematic literature review based on related articles retrieved from the Web of Science database and China National Knowledge Infrastructure database. The results showed the following: (1) Regarding time series, the average annual number of published works in the literature from 2000 to 2017 is less than 4, while the average annual number of published works in the literature from 2018 to 2022 is more than 97. The overall study on eco-product value realization and eco-industry has shown a year-on-year growth trend. (2) The research content primarily involves five aspects, including the connotation and extension of eco-products, eco-product supply, eco-product value accounting, eco-product value realization, and eco-industry. (3) It is essential to deepen the study on the improvement mechanism of the eco-product supply capacity, eco-products property rights, evaluation system for eco-product value realization, ecological compensation mechanism, driving mechanism for eco-products to eco-industry, and coupled development of ecological restoration and eco-industry. Based on the above research, this paper presents an enlightment of the forest ecosystem services in the karst ecological restoration area from three aspects: enhancing the supply ability of eco-products, improving the compensation mechanism of forest ecological services, and coordinating the development of ecosystem services and eco-industries.

Keywords: ecological products; value realization; ecological industry; value accounting

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1. Introduction

The extensive mode of economic development has seriously damaged the ecological environment; thus, changing the course of economic development and promoting ecological environmental protection is necessary [1]. A good ecological environment can provide more eco-products and services for people [2]. A hot topic is how to promote the transformation of ecological value by adding value to the ecological environment and natural resources and reflecting that in high prices, so that protecting the ecological environment can be rewarded and, thus, promote improving the ecological environment and coordinating economic development and environmental protection.

The concept of ecosystem services was first proposed by Holdre and Ehrlich in 1974 [3]. In 1997, Costanza [4] defined ecosystem services as representing the benefits human populations derive, directly or indirectly, from ecosystem functions. Since the definition was

proposed, it has attracted widespread academic attention and ecosystem services have been classified. The classification of ecosystem services defined by the Millennium Ecosystem Assessment [5]—provision, regulation, support, and cultural services—is generally accepted. The proposed definition and classification of ecosystem services provides the basis for valuing ecosystem services and quantifying the services that natural ecosystems provide to humans. Introducing ecosystem services has led to a focus on ecological conservation [6,7]. Researching ecosystem services encourages people to give more attention to protecting the ecological environment.

With environmental awareness being enhanced, "ecological products" appeared in the mid-1980s in China [8]. Ren and Yuan defined eco-products in 1992 [9]. In China's National Plan for Main Functional Zones in 2010, natural elements such as air, water, and the climate were each attributed as a "product" for the first time and classified into the category of eco-products [10]. The plan proposed that eco-products are the natural elements that maintain ecological safety, guarantee ecological regulation, and provide good living environments [10]. This definition is similar to that of ecosystem services [11]. At present, the definition of eco-products proposed by Zhang et al. is generally recognized and accepted by scholars [12]. They suppose that eco-products are terminal products or services which are provided for the use and consumption of human society by the interaction between the biological production within the ecosystem and the production of human society. The initial purpose of eco-products is to use them as a standard to measure ecological environmental protection when developing key ecological functional areas. With human demand for quality eco-products, local governments and academics have gradually carried out research on realizing the value of eco-products and other aspects. Most studies focus on the concept of eco-products [12,13], eco-product value accounting [14,15], and value realization paths and models [16,17]. The research on how to improve the supply capacity of eco-products and how to build an assessment system for the realization of eco-product value is rarely mentioned. Research in these aspects is necessary to improve the eco-product value realization mechanism.

Eco-industry is a network-evolved industry organized according to the principles of ecological economy and the laws of knowledge economy, with efficient economic processes and harmonious ecological functions based on the carrying capacity of the ecosystem [18]. The idea emerged in the 1970s and grew rapidly in the late 1990s [19]. The idea of eco-industry is widely used in product design and new product development for raw materials, energy, and other industries [18]. In addition, based on Jinping Xi's proposal that "lucid waters and lush mountains are invaluable assets", eco-industry can also depend on the ecological resources of ecosystems. To elaborate, ecological resources require ecological innovation; thus, through the ecological value realization mechanism, ecological resources are converted into products, with ecological industrialization enabling ecological resource protection and adding value to them [20]. This is a new industry that belongs to the coordinated development of ecological resource utilization, ecology, and economy. As a specific form of sustainable development, eco-industry harmonizes the unbalanced relationship between ecological protection and economic development [21], which is consistent with the goal of realizing the value of eco-products. On the basis of realizing the value of eco-products, how to drive the formation of eco-industry and establish the formation mechanism of eco-industry are the problems that need to be explored [22].

The global karst landscape covers about 15% of the world's total area, in which a quarter of the world's population lives [23]. China's karst area accounts for about one-third of the national land area, and it is one of the countries with the largest area of karst landscapes [24]. China's karst area is widely distributed with many types, mainly in its southern region. However, the karst ecosystem has been degraded due to unreasonable human activities, with a dramatic reduction in biodiversity and a gradual intensification of soil erosion, thus resulting in severe rocky desertification and causing the karst region to be vulnerable [25]. Rocky desertification has become an essential ecological problem restricting the development of regional economies and societies in South China's karst areas [26]. To reduce land degradation and promote ecological and economic development, scholars

have identified forests as the preferred target for ecological restoration in the region [27,28]. Management results have shown that forests are beneficial in stopping land degradation and provide products and services such as carbon sequestration, oxygen release, soil and water conservation, and timber in the control process [29,30]. Karst forest ecosystems contain enormous ecological service values, and their own values are conducive to human wellbeing [31]. At present, research on forest ecosystem services in karst restoration mainly focuses on assessing ecosystem services [32–34] and the tradeoff synergy between ecosystem services, and certain research results have been achieved [35–37]. However, owing to the high elasticity of karst desertification management, how to maintain a sustainable supply of forest ecosystem services requires continuous attention. Researching eco-product value realization and eco-industry can help promote the sustainable supply of forest ecosystem services for karst ecological restoration.

Agroforestry refers to a sustainable land use system formed by artificially combining multiple components such as woody plants, crops, and livestock breeding in the same land unit [38], which is a production mode designed to promote sustainable development of forestry [39]. It is included in the scope of forestry. As a type of forestry, agroforestry provides less biodiversity and ecosystem services than old-growth forests [40]. Based on the value realization of eco-products and eco-industry research, some researchers have proposed the enlightenment of agroforestry ecosystem services for karst ecological restoration [41], but they only focused on agroforestry. Therefore, based on the value realization of eco-products and eco-industry research, this study proposes that the supply capacity of forest eco-products can be improved by realizing forest ecosystem service function optimization through karst ecological restoration. The long-term dynamic observations and ecological protection of forest ecosystem service value in karst ecological restoration is established as the basis for formulating an ecological compensation standard, to improve the forest ecological compensation mechanism. The synergistic development of forest ecosystem services and eco-industry is proposed, for it aims to balance the development of ecological benefits and economic benefits.

Understanding eco-product value realization and eco-industry helps to coordinate ecological protection with economic development and promote ecological environment improvement. The study of eco-product value realization and eco-industry is in a rapid growth stage. Extensive studies have been conducted on eco-product value accounting, the value realization mode, and the value realization path. However, the value realization mechanism of ecological products still needs to be explored in depth, and the mechanism of how eco-products drive the formation of eco-industries is unclear. Therefore, based on a systematic review of the literature, this paper aims to (1) clarify the development trend of studies on eco-product value realization and eco-industry; (2) summarize the landmark achievements in eco-product value realization and eco-industry; and (3) condense the key scientific issues that need addressing in the study on eco-product value realization and eco-industry. This will help provide theoretical references for eco-product value realization and scientific support for transforming forest ecosystem service values in karst areas.

2. Materials and Methods

To identify relevant studies, a literature search was conducted based on the China National Knowledge Infrastructure (CNKI) and Web of Science (WOS) databases. To ensure the timeliness of the number of publications, the search date was on 31 December 2022. Figure 1 shows the process of the literature search and screening.

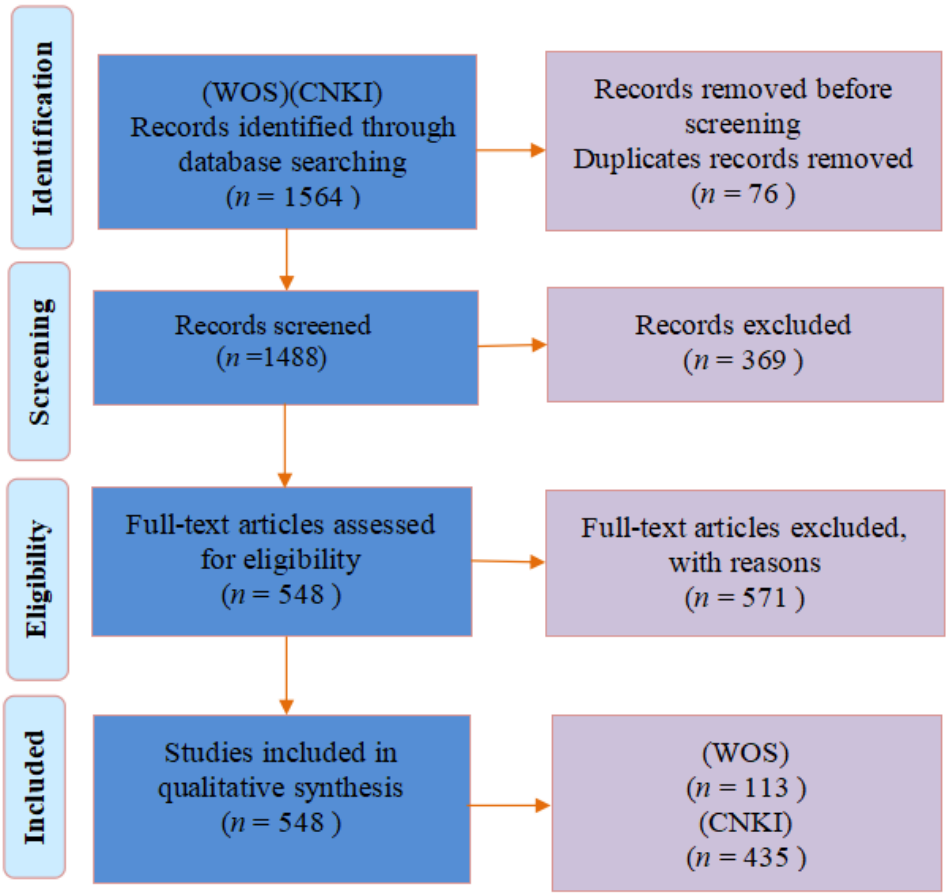

Figure 1. The process of the literature search and screening.

Above all, Chinese literature was obtained from CNKI. For CNKI, "item" was the search item, "eco-product value realization" was the search term for the first search, "eco-product" and "eco-industry" were entered into the subject for the second search, and finally, "ecosystem services" and "eco-industry" were the subjects for the third search. Next, English literature was obtained from the WOS database. For WOS, "theme" was the search item, "eco-product value realization" was the search term for the first search, "eco-product" and "eco-industry" were entered into the subject for the second search, and, finally, "ecosystem services" and "eco-industry" were the subjects for the third search. By removing any duplicate items from the literature, 1048 Chinese articles and 440 English articles were obtained. The statistical analysis was conducted on the retrieved articles. First, according to the realization of the eco-product value and the research content of eco-industry, the articles that were inconsistent with this research were screened out through article titles, keywords, and abstracts. Second, the full text was read to filter out the articles that were not relevant to this study. Lastly, 435 Chinese articles and 113 foreign articles were obtained, with a total of 548 Chinese and English articles.

3. Results

3.1. Annual Distribution of Reports

As shown in Figure 2, studies on eco-product value realization and eco-industry began to germinate in 2000 and has expanded swiftly since 2018. The studies can be roughly divided into two phases. The first phase has a total of 61 articles from 2000 to 2017. The related study started late, with an average annual publication volume of less than two articles, representing the embryonic phase. The second stage is from 2018 to 2022, which had a rapid growth phase, with a total of 487 papers, suggesting that this field of study has a broad future.

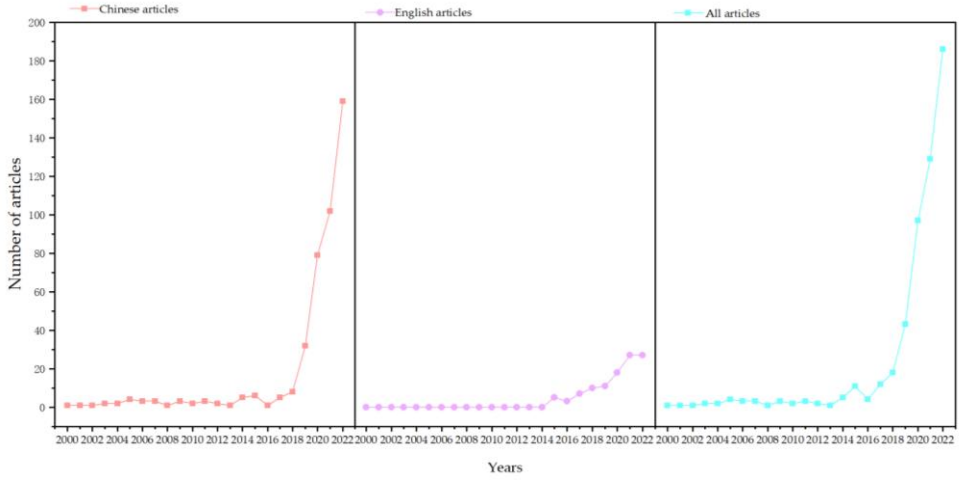

Figure 2. Annual distribution of articles.

3.2. Distribution of Research Areas in the Literature

As shown in Figure 3, the study institutions of eco-product value realization and eco-industry formation were counted. Regarding the regional distribution, the study units were mainly distributed in Asia (94.53%), followed by Europe (4.20%) and North America (0.73%), with less distribution in Africa (0.18%) and Oceania (0.18%). Asia is mainly distributed in China, India, Japan, and other regions; North America is mainly distributed in the United States and Canada; and Europe is mainly distributed in Sweden, the United Kingdom, and other regions. The largest number of articles was issued by Chinese institutions, followed by India, the UK, Sweden, and the US. This is inseparable from the concern of local governments and people for ecological protection and sustainable economic development.

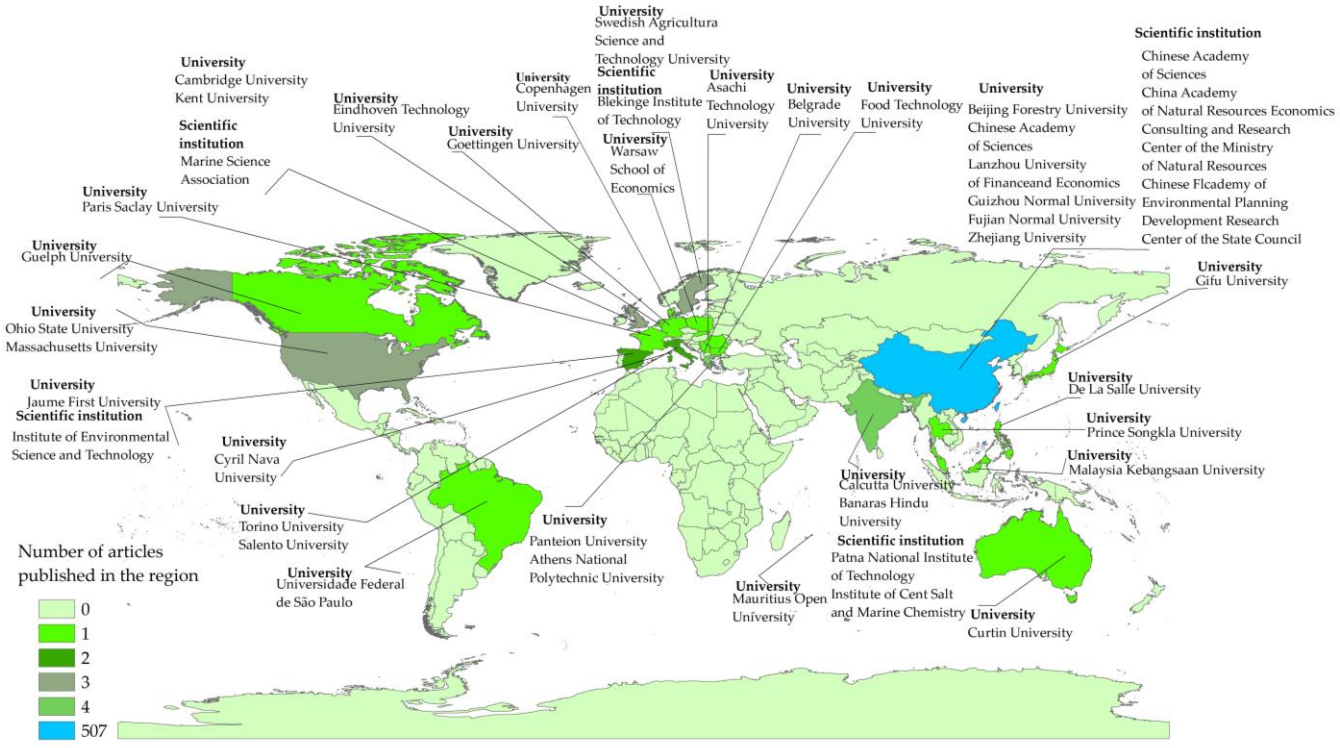

Figure 3. The breakdown of the institutions and nations described in the study (owing to space limitations, only institutions in China with more than seven publications are marked).

3.3. Institution Distribution of the Literature

Owing to the large number of issuing institutions, the number of institutions with more than seven articles was counted(Figure 4). Results of the statistical analysis show that the institutions with more than seven articles are all from China and that the top units in the number of publications in China are mainly divided into three categories: first, the scientific research units that have been engaged in ecological environmental protection and sustainable development for a long time include: the Environmental Planning Institute of the Ministry of Ecology and Environment (seven articles), the China Institute of Natural Resources Economics (eight articles), Development Research Center of the State Council (seven articles), and the Consulting and Research Center of the Ministry of Natural Resources (nine articles); second, the units in the regions where the national eco-product value realization mechanism points are located include: Zhejiang University (seven articles), Fujian Normal University (seven articles), Guizhou Normal University (nine articles); and, third, the unit whose research objects are mainly finance and resources, such as: Lanzhou University of Finance and Economics (eight articles). In addition, the colleges and universities related to forestry and agriculture are also the main publishing units, such as Beijing Forestry University (twelve articles), Eco-Environmental Research Center, Chinese Academy of Sciences (twelve articles), etc. In general, the article distribution for the research institutions is affected by factors such as research foundation and experience, geographical advantages, and majors.

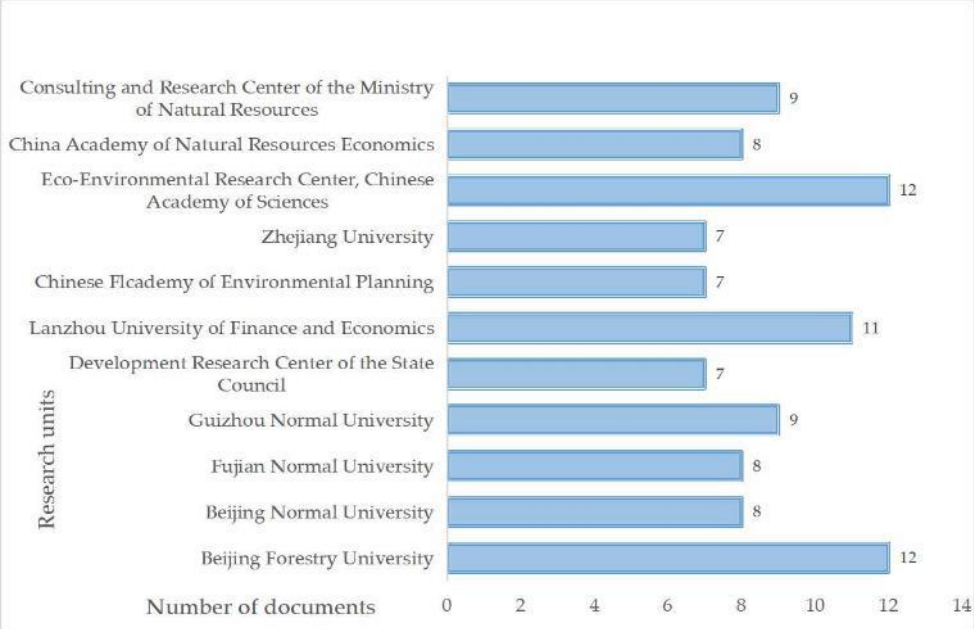

Figure 4. Literature by unit.

3.4. Content Distribution in the Literature

All of the identified literature is classified and summarized from the aspects of connotation and expansion, supply of eco-products, value accounting of eco-products, value realization of eco-products, and eco-industry (Figure 5). The literature on eco-product value realization accounts for 49.42%, mainly including eco-product value realization paths, models, and mechanisms. Eco-industry literature accounts for 21.82%, and mainly concerns technology research and development, industrial model construction, and experimental demonstration in eco-industry. The connotation and extension, and the value-accounting literature account for 12.28% and 11.27%, respectively. These are mainly about the concept and connotation of eco-products, value composition of eco-products, value-accounting indexes and methods, etc. The literature on the supply of eco-products accounts for 5.20% and mainly concerns the innovation of supplying the main body model, landscape planning,

and so on. These proportions in the literature indicate that research on the value realization of ecological products and eco-industries is becoming more mature, while the supply and value accounting of eco-products are still in the exploratory and developmental stages.

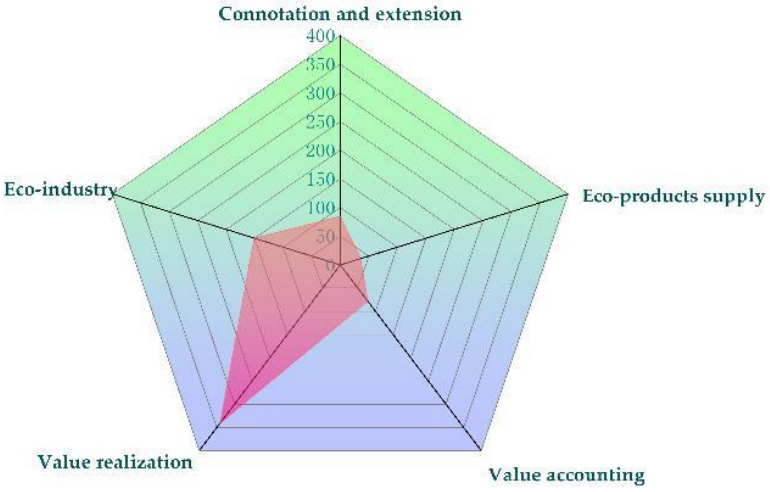

Figure 5. Research content division.

3.5. Division of the Main Study Stages

As can be seen from Table 1, the related studies started in 2000. According to changes in the research background, the studies about eco-product value realization and eco-industry are divided into two stages, namely, the sprouting stage and rapid growth stage.

Table 1. Division of the research stages.

Research Stage	Development Background	Main Features
Budding stage (2000–2017)	In 2010, China's national main functional area plan proposed the concept of "eco-products" for the first time, but there was no clear and unified concept. Some scholars have studied and discussed the concept and theory of eco-products.	There were less than four relevant articles per year, and mostly focused on the concept and theory of eco-products. For eco-industry development, it mainly focused on the transformation of traditional industries and the design and planning of ecological technology.
Period of rapid growth (2018–2022)	China has issued several documents and policies on the realization of eco-product value and carried out pilot projects sequentially, realizing the value of eco-products in several cities. Quality eco-products have become a scarce resource, and the coordinated development between ecologies and the economy is attracting increasing attention.	More than six relevant articles are published every year, and the average annual publication volume is more than 97. It is mainly about eco-product value accounting, realization path, mode, and mechanism research. A new industrial form has emerged around eco-products, and some scholars define it as the fourth industry of eco-products.

3.6. Major Progress and Landmark Achievements

3.6.1. Connotation and Extension

(1) Eco-product concept

As research has deepened, the academic community has maintained different views on defining eco-products. From the perspective of the natural environment, eco-products, as important components of the ecosystem, are natural elements that can maintain ecological security, safeguard ecological functions, and provide a good living environment [42]. From the perspective of social development, eco-products also include products that humans dedicate a certain amount of labor to and use in production, such as eco-agricultural

products and eco-industrial products produced through clean production, recycling, energy conservation, and emission reduction [12].

(2) Eco-products classification

Classifying eco-products is a prerequisite for studying their supply patterns and operational mechanisms [43]. Currently, there are several approaches to classifying eco-products. First, eco-products are classified into public eco-products, quasi-public eco-products, and commercial eco-products, according to different paths and modes for realizing their values [12]. Second, based on the theory of public goods, eco-products are divided into national public eco-products, regional or regional public eco-products, community public eco-products, and "private" eco-products [43]. Third, eco-products are divided into natural-factor eco-products, natural-attribute eco-products, eco-derived eco-products, and eco-label products, according to supply attributes [44]. Fourth, eco-products can be divided into ecological material products, ecological regulatory services, and ecological cultural services according to their manifestations and functions [45]. This is similar to the classification of ecosystem services into support, supply, regulation, and cultural services proposed by the Millennium Ecosystem Assessment [5].

(3) Composition of eco-product value

The types of eco-products are diverse and their value compositions are diverse. An eco-product's value is mainly manifested through its ecological, social, and economic value [46]. Its value permeates in human life and production, cultural needs, economic development, and other aspects [47]. Among them, the economic value of eco-products is realized by directly participating in market transactions, which is also the embodiment of direct-use value. The ecological value of eco-products is reflected in the natural value of eco-products, which shows the function of eco-products in the process of conservation, restoration, and regeneration of the whole ecosystem. It is also the embodiment of the value of indirect use [48]. Social value refers to the value of eco-products embodied in the process of enriching human spirit and culture and satisfying human needs for a better living environment [49]. It is a concrete expression of nonuse value.

3.6.2. Eco-Product Supply

Several studies have improved eco-product supply capacity from the perspective of supply-agent model innovation and spatial planning [42,50]. The single mode of supplying eco-products is not conducive to efficiently supplying eco-products. Some scholars use game theory to analyze the relationship between eco-product supply subjects by building a multicentered supply mechanism with the government as the main body and the market and society working together to enhance the effective supply of eco-products [51]. Moreover, from the perspective of the relationship between macro- and microsuppliers of eco-products, Zhang et al. [52] proposed multiple supply models such as a government-led supply model, government-participatory market model, government-service-oriented guarantee model, and government-cooperative promotion model. Supply-mode innovation not only realizes the diversification and individuation of supply content but also guarantees the supply efficiency and quality of eco-products. From the perspective of spatial planning, the normal play of ecosystem service functions depends on effective protection, restoration, and expansion [53]. Therefore, some scholars start with regional landscape planning to promote restoring damaged ecosystems by assigning various landscape types, quantities, and spatial patterns, thus improving the quality of the regional ecological environment and enhancing the supply capacity of high-quality eco-products [54].

3.6.3. Eco-Product Value Accounting

Quantifying the value of eco-products is fundamental to incorporate the welfare and conservation effects of ecosystem services on humans into all decisions and is a prerequisite to realizing the value of eco-products [55,56]. Currently, there is no unified method to account for the value of eco-products, and the main approach is assessing the value of ecosystem

services. There are three main methods. The first is the equivalence factor method [57]. This is based on different types of ecosystem service functions, using quantifiable criteria to construct the equivalent value of different types of ecosystem service functions [58,59]. Wang et al. [60] quantitatively analyzed the spatial and temporal distribution characteristics of land use changes and ecosystem service values in Xinjiang from 1990 to 2020 using equivalent factors combined with spatial autocorrelation and sensitivity. The second is the functional value method [61]. The service types are divided based on clear ecosystem types. Based on various monitoring and statistical data, the number of products and services provided by the ecosystem is calculated and multiplied by the price to obtain the total value [62,63]. Different types of eco-products require different functional value methods (Table 2). Mou et al. [64] used the functional value approach to estimate the value of ecosystem product supply, regulation service, and cultural service in the Yanqing district. The third is the emergy analysis method [65]. Based on the solar energy value required by each type of ecological resource to provide ecological services as a link, the service value for different types of ecological resources is calculated, and finally expressed in emergy units [66–68]. On account of the emergy analysis, Liu et al. [69] constructed the service accounting method system provided by the agroecosystem and calculated the typical agricultural ecosystem services per unit area in China.

Table 2. Classification of functional value method.

Type	Methods	Advantages	Disadvantages
Functional value method	Market value method [4]	It can directly evaluate some of the value of ecological service function and is widely recognized by the public.	Products and services that can be traded through the market are evaluated, their indirect benefits are ignored, and they are easily influenced by market institutions and policies.
	Alternative cost method [70–72]	The alternative approach solves the problem of estimating the value of ecosystem services in terms of the willingness to pay.	The method's effectiveness depends on the public's grasp of the information and the calculation of the cost produces errors.
	Shadow engineering [73,74]	The value of the ecological service function, which is difficult to estimate directly, can be calculated and processed using alternative engineering methods.	The replacement project is not unique, and the replacement project has great differences in time and space.
	Cost of protection method [75]	No detailed information or materials are required.	The value is affected by many factors, cost being only one of them, and it is easy to underestimate.
	Usage-of-travel fee [76]	Established based on the market, recognized by the public, and has a high degree of recognition.	The assessment results are influenced by local economic conditions.
	Hedonic price method [77,78]	Based on the market, it reflects the actual preference of consumers and has high credibility.	The statistical models are complex.

3.6.4. Eco-Product Value Realization

Through some studies, local governments and scholars have produced explorations and summaries on the mode of eco-product value realization. Its main models can be summarized as the ecological resource index and property rights trading model [79], ecological protection compensation model [80], ecological industrialization management mode [81], green finance model [82], and ecological protection and restoration, maintenance and appreciation model [83]. For example, the "Chongqing Land Stamp Model" [84] and "Fujian Forest Ecological Bank" [85] realize the value of eco-products through the capitalization of ecological resources by implementing the flow of ecological resources. For regulating service products, we mainly adopt the ecological protection compensation method to achieve the goal of protecting the environment and social benefits through governmental and market-based paths of ecological compensation [86,87]. Costa Rica has

been able to achieve a win–win situation in terms of forest conservation and economic development through market-based operations, relying on diversified funding channels and a differential compensation standard [88]. Material products and cultural service products need to rely on the organic combination of natural, constructed, and human capital to transform ecological advantages into economic advantages through management and development [89]. Zhou et al. [90] analyzed that the value realization of the Zhangye Danxia landform in the original ecological mode relies on government policies, government actions, scientific research institutions and researchers, local enterprises, farmers, and other forces to realize its value through developing ecological tourism. The green finance model is used to effectively reduce polluting projects and improve the investment return and financing availability of green projects [82]. Green finance provides products such as green credit, environment and climate fund, ecological trust, ecological insurance and ecological benefit bonds to realize resource and capital complementarity [81]. The normal operation of green finance requires a mature legal system, sustainable market conditions, and a sound infrastructure construction system [91]. For areas with damaged ecological environments, the mode of ecological protection and restoration and value preservation and appreciation should be adopted to restore the natural ecosystem's structure and function, enhance eco-product supply capacities, and improve eco-product value by repairing the damaged ecosystem [92]. Concerning China, some experiences in eco-product value realization have been summarized for river basin management [93], mine ecological restoration [94], and marine ecological restoration [95].

3.6.5. Eco-Industry

In the industrial age, humans have neglected the environment's importance, thus resulting in the increasing contradiction between resources, environment, and economic development. Therefore, eco-environmentally friendly industry, circular economy, and the design and optimization of eco-industrial parks have become the research focus [96,97]. Their purpose is to harmonize the relationship between the ecological environment and economic development and achieve regional sustainable development. The speed of knowledge flow and technology flow in the eco-industrial park ecosystem is fast, which drives the speed of material, energy, information, and value flows in the system, strengthening its ecological function [98]. Therefore, eco-industrial parks are an important vehicle to promote environmentally friendly industries and develop a circular economy. In eco-industrial parks, existing resources can be fully utilized to minimize waste emissions and environmental pollution by connecting clean production and eco-industrial chains [99]. In addition, the ecological carrying capacity and industrial ecological suitability also need to receive focus [100]. Industrial ecological suitability is an assessment of the suitability and limitations of industrial development and resource exploitation based on regional natural environment characteristics, resource endowments, environmental capacity, social and economic development needs, and the planned industrial structure, industrial layout, and development scale [101]. The ecological carrying capacity determines the type and spatial layout of regional industry. The ecological carrying capacity has become an important constraint on regional industry development [101]. Therefore, the ecological carrying capacity factor is considered when assessing the industrial ecological suitability, which facilitates optimizing the industrial structure.

Entering the age of ecological civilization, the traditional division of labor among the three industries cannot meet the needs of industrial development. Ye et al. [102] proposed defining waste recycling as the fourth industry, thus expressing the worth of environmental production. However, it is too incomprehensive to define ecological environmental production only as waste recycling. Subsequently, Wang et al. [103] proposed the concept of the fourth industrial product from the viewpoint of eco-products, further analyzed its formation mechanism and constituent elements, and constructed a system of evaluation indicators for developing the fourth industrial product. With a continuously improving eco-product value realization mechanism, the fourth industry of eco-products is being

formed around eco-product supply and value realization. Nonetheless, the fourth industry of eco-products is in the early stage of formation, and the theory and practice still need to be expanded. Further clarifying the boundary of the fourth industry of eco-products, standardizing the industrial classification system, strengthening the development index system, and aligning with the economic accounting system to promote the sustainable development of the fourth industry of eco-products are all recommended [104].

With the concepts of eco-industrialization and industrial ecologization being promoted, the eco-industry has been developing. Eco-products are the basis of ecological industrialization and industrial ecologization [105]. Eco-industrialization refers to the process of forming various industries through market-oriented means relying on existing natural environment resources and finally realizing the value-added process [106]. Eco-industrialization emphasizes transforming and applying ecological resources in the industrialization process. It is necessary to consider the ecological effects. The sustainable use of ecological resources can only be achieved through protection during development. Industrial ecologization refers to the process of using resource-saving and environmentally friendly new technologies to transform and upgrade various industries to achieve green production [107]. Industrial ecologization is an inevitable requirement of sustainable development and an effective integration of economic and social development and ecological protection. Therefore, eco-industrialization is mostly appropriate for areas with better ecological resources. Producing eco-products facilitates ecological industrialization, which is one of the intrinsic drivers of value realization; industrial ecological transformation promotes the improvement of ecological concepts and enhances the demand for eco-products, which is the external driving force to realize the value of eco-products [22].

4. Discussion

4.1. Differences in the Value Realization of Eco-Products and the Annual Volume of Eco-Industry Publications

The number of articles related to eco-product value realization and eco-industry is rapidly increasing (Figure 2). Therefore, discussing eco-product value realization and eco-industry is a valuable research topic. Since the emergence of eco-product value realization and eco-industry research, the number of articles has been increasing in the rapid growth phase, accounting for 88.86% of the overall number of papers. In the early stage, eco-product value realization and eco-industry research mainly focused on the concept and theory of eco-products. As the research progressed, the literature on the path, mode, and mechanism of eco-product value realization gradually increased. Local governments also began carrying out pilot projects on eco-product value realization in different regions and summarizing different value realization models. Relevant research on eco-product value realization and eco-industry is mainly in key ecological function areas, national parks, and agricultural products, and there are also some relevant studies on forest eco-product value realization. However, there are few studies on the value realization of forest eco-products in karst ecological restoration. There is a lack of research on how eco-products drive eco-industries' formation mechanisms.

4.2. Differences in the Distribution of Research Areas

The differences in natural economic conditions and social situations among regions contribute to the uneven development of eco-product value realization and eco-industry research (Figure 3). Regarding the number of publications, Asia has the largest number of publications, accounting for 94.53%, while Europe, North America, Oceania, and Africa are less distributed, and account for 4.2%, 0.73%, 0.18%, and 0.18%, respectively. Among them, China has the highest number of publications, with a total of 92.51% of publications. This may be because the concept of eco-products was presented by Chinese scholars, and international academics use the concept of ecosystem services more than eco-products. Additionally, it may be related to the use of the CNKI database. Pilot projects on ecosystem goods value realization have been carried out in various parts of China, and these pilot

projects have developed models worthy of emulation. As a result, the number of articles that describe studies of eco-product value realization and eco-industries is increasing.

4.3. Key Scientific Problems and Prospects to Be Solved at Home and Abroad

Based on the research status of eco-product value realization and eco-industry, this study summarizes the problems of eco-products shortage, unclear quantity and ownership boundary of natural resource assets, insufficient subsequent guarantee for eco-product value realization, single ecological compensation models, insignificant implementation effects, and insufficient internal driving force of eco-product to eco-industry. There are also some problems, such as the deterioration of the ecological environment caused by the unreasonable industrial structure. Among them, the remaining challenges in this field are how to clarify the number and ownership boundary of natural resource assets, and how eco-products drive the formation mechanism of eco-industry.

4.3.1. Mechanism of Improving Eco-Products' Supply Capacity

In response to the current shortage of eco-products, improving the supply capacity of eco-products is necessary [108]. Currently, research on the supply capacity of eco-products has focused on improvement paths and strategies, such as innovating supply motifs, ecological space optimization [109], certifying eco-products [110,111], and landscape planning [112,113]. However, less research has been conducted on enhancing eco-product supply capacities by optimizing ecosystem service functions [114]. By optimizing the ecosystem structure, the ecosystem's stability is enhanced, the ecosystem's integrity is ensured, the ecosystem's service function optimization is realized, and the ecosystem's quality is improved to provide more eco-products.

4.3.2. Building an Open and Shared Eco-Product Information "Cloud Platform"

Given the problems of unclear natural resource asset basis and ownership boundaries, we combine digital technology applications to build an open and shared eco-product information database. Eco-products require clear property rights before they can be transformed into manageable production factors. However, in natural public resources with characteristics of dispersion, mobility, and cross-region, such as rivers, forests, climate, and other ecosystems, there are problems such as the unclear property rights ownership of eco-products. Therefore, establishing a multisource monitoring mechanism for eco-products and a unified system of natural resource classification standards is necessary [115]. By fully utilizing the latest digital technologies such as big data, we organize and carry out a nationwide "pre-investigation" of natural resource assets. At the same time, we must also dynamically adjust and optimize the classification standards according to the actual situation in different regions, build an open and shared "cloud platform" for eco-product information, and establish an eco-product catalogue information system to facilitate the timely tracking and grasping of information on eco-product quality grades, ownership, quantity distribution, etc. [116].

4.3.3. Establishing an Evaluation System for Realizing the Value of Eco-Products

Regarding the insufficient follow-up guarantee for realizing eco-product value, an assessment and evaluation system for realizing eco-product value should be constructed. Some studies have shown that why excellent eco-products become scarce is inseparable from the neglect of including ecological protection in environmental consciousness. This stems from adopting the extensive development mode in the past. Therefore, scholars and local governments should give attention to research assessing eco-product value realization to guarantee the sustainable development of eco-product value realization. The evaluation system of eco-product value realization should be constructed according to local conditions, and the accounting results of natural resource asset quality and eco-product value should be regarded as an important reference for evaluation. For the key ecological functional areas mainly providing eco-products, we should focus on assessing the eco-product supply capacity, environmental quality improvement, ecological protection effectiveness, and other

indicators [117]. Most assessments of social and economic development only considered gross domestic product (GDP) unilaterally. In the future, it will be necessary to consider applying gross ecological product (GEP) indicators when evaluating relevant local government performance. The assessment results of GDP and GEP will be implemented in property rights transactions, ecological compensation, and ecological and environmental damage compensation.

4.3.4. Improving the Ecological Compensation Mechanism

In response to the problems of single ecological compensation models and insignificant implementation effects, a corresponding benefit evaluation and monitoring system should be established, and a corresponding response should be proposed to improve the ecological compensation mechanism. Most studies on ecological compensation standards and ecological compensation pathways are more extensive, but there are relatively few studies on ecological compensation that affect monitoring and environmental dynamics after ecological compensation implementation. Dynamic monitoring using GIS and RS technologies can meet the objectives and needs for large-scale, efficient, and accurate monitoring and understanding of ecological environment conditions and change factors such as soil cover, vegetation conditions, and soil erosion across study areas. In addition, ecological protection costs together with regional ecological and environmental management investment and effectiveness are included when evaluating ecological compensation benefits, and long-term dynamic observation is used as the basis for ecological compensation standard development to improve the ecological compensation standard system [118].

4.3.5. Driving Mechanism of Eco-Products in Eco-Industry

Eco-products contain strong ecological and economic value. With the development of the social economy, the social demand for eco-products has been gradually increasing. Eco-products are the basis for forming eco-industries, but there is still a lack of an internal driving force for forming them. In the future, research must focus on integrating eco-products, socializing the re-operation of eco-products, cultivating eco-product market agents, and constructing eco-product market circulation systems. By investigating the spatial distribution, quantity, and size of eco-products and being guided by the product size and spatial concentration, product distribution and distribution centers are developed to provide a basic platform for market transactions. We will strengthen the processing of material products and brand building and promote integrating primary, secondary, and tertiary industries. According to the spatial distribution in the main body supply, the supply capacity, cost revenue, and market supply main body need to be cultivated. According to the spatial distribution, consumption potential, demand size, and willingness to pay for consumer agents, the market consumer agents are cultivated. Integrating product distribution, market circulation, trading platform construction, and product trading paths will build the eco-industry market circulation system to realize eco-product values.

4.3.6. Research on the Coupled Development of Ecological Protection and Restoration and Eco-Industry

The problem of unreasonable industrial structures deteriorating the ecological environment has affected regional sustainable development. It is necessary to accelerate the research on the coupled development of ecological protection and restoration and eco-industry. The organic coupling and coordination of industry and ecological restoration is conducive to the coordinated development of economic, social, and ecological benefits. Combining ecological protection and eco-industry in ecological restoration areas has attracted increasing academic attention. Eco-industry is the most suitable industry to realize the coordinated development of ecological protection and economy in ecological restoration areas. By establishing the coupling mechanism of the ecosystem carrying capacity and eco-industry in ecological restoration zones, we clarify their relationship and explore the optimization of the industrial layout. To clarify the stability between inputting ecological

protection and restoration and developing eco-industry, a coupled coordination model of ecological protection and restoration and eco-industry is constructed based on the theory of the coupling coordination degree, and the coordination degree between them is clarified. However, the coupling mechanism between ecological restoration and industrial models is still in the exploratory phase, and there are few studies on integrating key technologies and processes in coupled systems. In the future, the process characteristics, coupling purpose, and overall benefits of coupled systems should be fully considered, and the degree of coupling coordination should be used as a theoretical approach to evaluate the coordination between the two systems.

4.4. Enlightenment toward Forest Ecosystem Services in Karst Ecological Restoration

Under the background of large-scale karst forest ecological restoration, the area of rocky desertification has gradually decreased in China [119]. The ecological restoration of karst forests involves not only restoring forest vegetation, but also restoring and reconstructing the structure and function of the whole ecosystem, the above- and belowground biodiversity, the ecological value and economic value, etc. [20]. The karst rocky desert ecosystem can be improved by artificial afforestation and closed mountain afforestation (Figure 6). The results show that forest ecosystem services are beneficial to controlling degraded land and play an essential role in local agricultural and forestry production, improving people's living conditions, and maintaining the ecological environment. Controlling the desertification of karst involves acknowledging that it is prone to recurrence. How to promote the sustainability of forest ecosystem services in karst ecological restoration is worth considering.

(**a**) (**b**)

Figure 6. Measures to control rocky desertification: (**a**) artificial afforestation; (**b**) closed mountain afforestation.

4.4.1. Increasing Supply Capacity

Southwest China's karst area is the country's largest contiguous poverty-stricken area. In recent years, in the rocky desertification control process, poverty alleviation and economic improvement, the development of characteristic industries, and the large-scale planting of economic forests and fruit forests, fast-growing timber forests, and other artificial forests, have all occurred in the karst areas [119]. The area of plantation forests significantly accelerated the increase in vegetation coverage and biomass in karst areas and increased the regional wood stock [120]. However, plantation tree species are relatively monophyletic, have low biodiversity conservation functions, and have increased the incidence of pests and diseases. It is also limited by the shallow soil layers, insufficient total soil, and lack of mineral nutrients in the karst region [120]. These factors also lead to the poor stability of ecologically restored forest ecosystems. Karst ecological restoration cannot just blindly pursue the "greening" of vegetation coverage, but must turn to improving the quality of karst ecological restoration forest ecosystem services and regional development. Forest species allocation involves optimizing the forest ecosystem structure, enhancing the forest ecosystem structure's stability, maintaining the forest ecosystem integrity, realizing

the forest ecosystem service function optimization, promoting the overall improvement of karst forest ecosystem quality, and enhancing the supply capacity of forest eco-products.

4.4.2. Improving Mechanism Compensation for Forest Ecological Services

Ecological compensation has been used to solve environmental problems and promote the sustainable provision of ecosystem services [121,122]. A reasonable forest ecological compensation scheme is conducive to protecting forest resources and sustainable ecological development. According to the ecological environment problem in karst areas and the need for a national security ecological barrier, the principle of "who protects, who benefits, who develops, who protects" should be highlighted in the artificial forest ecosystem and the closed forest ecosystem formed in the rocky desertification control process. In the future, long-term dynamic observations of forest ecosystem service value and ecological protection input for karst ecological restoration should be used as the basis for formulating ecological compensation standards and constructing long-term ecological compensation plans. To ensure the effective functioning of the ecological compensation program, it is necessary for the ecological compensation authority to track the whole compensation process and manage it. In addition, ecological compensation benefit assessment should be carried out.

4.4.3. Synergistic Development

Ecosystem services lay the foundation for eco-industries, which can consolidate and enhance the quality of ecosystem services [123]. Therefore, we should focus on the coordinated development of forest ecosystem services and forest ecological industries in karst regions. A karst ecology–restoration forest ecosystem service aims to provide high-quality materials and service products for the survival and development of local rural residents without compromising the ecosystem's stability and integrity. The forest eco-industry must promote local economic development under the premise of realizing the protection and sustainable utilization of forest resources. The former aims to promote ecological priority, through green and high-quality industrial development, while the latter aims to consolidate the results of economic development and focus on the ecosystem's stability and integrity. Different from other forest eco-industry development areas in the world, the previously fragile ecosystem patterns and functions are further degraded due to the karst's fragility and unreasonable human activities, with the spread of rocky desertification and other ecological problems being exacerbated. Therefore, it is necessary to assess the ecological and economic benefits of forest industrial structures in the karst regions. The forest industry structure can then be optimized to improve the service function of the ecological restoration forest ecosystem. Finally, with the actual situation of karst ecological restoration and its own advantages, we will actively explore ways to extend the forestry industry chain and promote developing the characteristic forest industry through cultivating and developing the characteristic forest products under the premise of ecological security (Figure 7).

(**a**) (**b**)

Figure 7. Rocky desertification control derivative industry in Guizhou: (**a**) prickly pear-planting industries; (**b**) under-forest chicken-raising (source: https://sck.gznu.edu (accessed on 23 October 2022)).

5. Conclusions

In this study, we analyzed a systematic review by statistically analyzing 548 papers retrieved from the WOS and CNKI databases and concluded the following: (1) Regarding the number of publications, there has been a rapid growth trend since 2018, and the research process has experienced budding (2000–2017) and rapid development (2018–2022) stages. (2) The research region is mainly concentrated in Asia, which accounts for 94.53%, with China having the highest number of publications, with a total of 92.51% of publications. This is followed by Europe, with 4.2%. (3) Regarding research content, eco-product value realization research is the most abundant, accounting for 49.42% of the total, followed by eco-industry, accounting for 21.82% of the total; connotation and extension, and also value accounting, accounting for 12.28% and 11.27% of the total, respectively; and eco-product supply, which was relatively low, accounting for 5.20% of the total.

The following are ideas for future scientific problems and solutions that need attention: (1) For the shortage of eco-products, the eco-product supply capacities must be improved. This can be achieved by optimizing the ecosystem's structure, enhancing the ecosystem's stability, and realizing the ecosystem's service function optimization. (2) Regarding problems such as unclear boundaries in the quantity and ownership of natural resource assets, an open and shared eco-product information database should be built in conjunction with digital technology applications, and an eco-product catalogue information system should be established to keep track of information, such as the grade of eco-product quality, ownership of rights and interests, and quantity distribution, in a timely manner. (3) Because ecological environment quality can easily be ignored, an assessment and evaluation system for ecological product value realization should be constructed. The quality of natural resource assets and eco-product value-accounting results should be regarded as important references for assessment and evaluation. Additionally, the GEP index should be included when applying the relevant performance assessment of local governments. (4) Because the eco-protection compensation for eco-products is not obvious and the ecological compensation model is singular, it is necessary to establish a corresponding benefit evaluation and supervision system, and based on the benefit evaluation results and long-term dynamic monitoring, put forward applicable countermeasures to improve the ecological compensation mechanism. (5) To address the insufficient internal driving force of eco-products in eco-industry formation, research should be conducted on integrating eco-products, cultivating the main market of eco-product supply and of eco-product consumption, and constructing the eco-product market circulation system to drive eco-industry formation. (6) Because unreasonable industrial structures affect the sustainable development of regions and are deteriorating the ecological environment, accelerating research on the coupled development of ecological protection and restoration and eco-industry is necessary. Using the coupling coordination degree theory, a coupling coordination model of ecological protection and restoration and eco-industry can be constructed.

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